METHOD OF REPRESENTING BINARY DATA

CROSS-REFERENCE TO RELATED APPLICATION

This application is a continuation-in-part of U.S. Ser. No. 08/148,423 filed Nov. 8, 1993 now abandoned which was a continuation of Ser. No. 07/733,171 filed Jul. 19, 1991, now abandoned.

FIELD OF THE INVENTION

This invention relates to a method for representing binary data in a graphic array so that it can be recorded in a tangible form such as being printed by means of standard commercial printing processes. Such printed data can then be reconstituted to its original binary form by means of an image scanner and a computer program that extracts the binary data from the scanned image.

BACKGROUND OF THE INVENTION

OCR

Optical Character Recognition (OCR) technology is widely used for regenerating text data from printed texts. OCR is essentially a software technology that handles the conversion of image data to binary text data.

The reliability of OCR is not perfect, but improvements are still being made. OCR, despite its imperfections, is very usable as a data acquisition tool in electronic text editing. It does not follow, however, that OCR is a technology that is well suited to be a communication vehicle between machines. There are three arguments against it: First, the graphic appearance of alphabetic letters (or numbers) responds to the requirements of human readers. Reading them with a machine commits far more processing resources to the task of character recognition than would have to be mobilized for the recognition of graphic symbols purposely designed for machine readability. The extra effort can only be justified in terms of adding value to primarily human-readable text systems. Second, the data density per area of printed matter in the case of human-readable text falls far short of the limits of the involved technologies. Third, each binary code (0 to 255) cannot be represented by a character. Only about one third of the 256 binary codes are unequivocally assigned to characters. Others are assigned to characters in a non-standard way and some codes have no character assignments. Spelling out numbers, each one with two hexadecimal digits, would solve the problem but at the expense of further deteriorating the achievable data density.

Bar Codes

Several bar code formats are in wide use today, mainly for product identification. Bar codes encode information in one direction only, generally along a line. The perpendicular direction encodes no information, but carries redundancy, extending the horizontal data pattern over a comparatively large area, so that the pattern retains its functionality even with a certain degree of degradation and so that the bar code requires little mechanical coordination in aligning the reading machine with the pattern.

Bar codes store little information. They are well-suited for storing machine-readable identification codes, but for the transmission of bulk data, bar codes require far too much printed area per data unit to be of practical use. They typically occupy many times the area regular text would. By shortening the redundancy dimension of a bar code pattern, its data density could be proportionally increased. But the required accuracy of reader alignment would become more stringent in equal proportion.

In exceptional circumstances, very small amounts of data proper need to be conveyed. Bar codes are then appropriate to convey such data. An example would be timing information some TV program guides publish in the form of bar codes. Programming a video recorder to record a specific program becomes a simple matter of pulling a bar code reader pen across the pattern for the desired program.

Dot Codes

Dot code systems use both dimensions of a flat surface to record information. Dot codes are inherently hard to read. They require precise synchronization of the reading apparatus with the data pattern. Namely, the data read is a reconstructed sequence of the original data only if the reader is accurately aligned with the rows of data dots. This requirement is all the more exacting in the light of the high data densities dot code systems attempt to achieve and the correspondingly fine dot screens they would employ.

If a reading machine is not synchronized or aligned with the data pattern, sequentiality is lost and would have to be reconstructed. Some kind of reference information would have to be introduced as a synchronization aid, as such information is essentially impossible to extract from the dot pattern itself (autocorrelation).

Dot code systems of the first kind (synchronized reader) have been proposed. They focus on reader synchronization, their major technological component. Such systems have not been successful in the marketplace. They necessitate dedicated high-precision machinery whose cost might well offset the benefits of their use.

SUMMARY OF THE INVENTION

Accordingly, an object of the present invention is to provide a method of representing binary data in a machine readable graphic form. Data so represented is able to carry relatively large amounts of data per unit area, to be reproduced by traditional photomechanical means and to be reconverted to their original binary form using low-cost image scanners. The method furthermore offers great flexibility in arranging a data rectangle in terms of scale and aspect ratio.

Briefly described, the invention centers on the idea that a judicious design of dot code patterns combined with an appropriate encoding and decoding software will endow available machinery with new capabilities in such a way that a novel method of data transmission can be cost-effective, which it manifestly cannot as long as its realization requires dedicated hardware.

The essence of the invention is a machine-readable graphic reference pattern that can be located with great precision by the reconstituting program. From this reference pattern the program is able to calculate the exact position of the graphic elements that contain the data proper. Thus the reference pattern and the data proper constitute a systematic unit which in the proposed form has the additional advantage of permitting combining such units in scalable rectangular arrangements of selectable aspect ratios.

BRIEF DESCRIPTION OF THE DRAWINGS

In order to impart full understanding of the manner in which these and other objects are attained in accordance